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6. AUTHOR(S)

Glen Gawarkiewicz, James Lynch, and Albert Plueddemann

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Woods Hole Oceanographic Institution
Woods Hole, MA 02543

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Department of the Navy
Office of Naval Research
Boston Regional Office
495 Summer Street, Room 103
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14. ABSTRACT

This project involved an AASERT grant to perform analysis of acoustic and oceanographic data from the Shelfbreak PRIMER experiment. The student completed his Ph.D. within the MIT/WHOI Joint Program. The thesis was entitled "Analysis of Acoustic Propagations in the region of the New England Continental Shelfbreak" by Brian Sperry

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			UL	7	19b. TELEPHONE NUMBER *(include area code)* (508) 289-2913

FINAL REPORT
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Glen G. Gawarkiewicz
Woods Hole Oceanographic Institution
360 Woods Hole Road, Mail Stop 21
Woods Hole, MA 02543-1541
Telephone: (508) 289-2913
Fax: (508) 457-2181
E-mail: ggawarkiewicz@whoi.edu

Long-Term Goals

The long-term goal of this project was to use high-resolution physical oceanographic and acoustics data collected during the Shelfbreak PRIMER Experiment to relate variability within the physical environment to variability of acoustic propagation in a shelfbreak region.

Objectives

The specific objectives were to analyze the leading edge arrival times of a 400 Hz source to examine the temporal variability of travel time perturbations along the easternmost path of the PRIMER array. The high-resolution hydrography along the propagation path was also examined to determine the effects of mode coupling on the distribution of arrival times, and hence the possibility of tomographic inversions to estimate the temperature field within the mooring array.

Approach

The high-resolution hydrography obtained from the SeaSoar survey along the easternmost propagation path was used within propagation models to examine the day-to-day variability of the leading edge arrival times. In addition, the mode coupling was examined within the model runs to determine the importance of mode coupling along the propagation path. Additional model runs included the effects of soliton propagation on the mode coupling.

Tasks Completed

The propagation modelling along the eastern line, the effects of soliton propagation on mode scattering, and a tomographic inversion of the depth-averaged temperature along the propagation path were completed. In addition, a theoretical treatment of horizontal coherence was developed and applied which allows the separation of water column versus sub-bottom contributions to the horizontal coherence.

Results

The analysis of the PRIMER data revealed that both the presence of the shelfbreak front as well as internal solitons generated at the shelfbreak had significant effects on the acoustic propagation. During the experiment, a large amplitude meander of the front propagated through the array. This resulted in travel time perturbations of as much as 80 milliseconds. The modelled travel time perturbations compared well with the observed fluctuations in the travel time perturbations (Figure 1).

The propagation modelling revealed that both the shelfbreak front and the internal solitons resulted in substantial modal coupling. This meant that only the leading edge arrival times were useful in attempting tomographic inversions. As a result, only the depth-averaged temperature along the propagation path could be obtained (Figure 2). The inverted temperature compared well with the observed depth-averaged temperature obtained from the SeaSoar transects.

The normal mode coherence was derived using a modal phase structure function. This phase difference function for individual modes as a function of frequency was calculated. The results suggest that at horizontal scales comparable to 20 times the wavelength, only modes 1 and 2 are close to being coherent (Figure 3). This compares well with prior observations in which 30 times the wavelength was observed as the maximum coherence length in shallow water.

The work resulted in one Ph.D. thesis (Sperry, 1999), as well as two manuscripts which have been submitted to refereed journals (Lynch *et al.*, 2000, and Sperry *et al.*, 2001).

Impact for Science

The work completed under this grant showed the importance of both mesoscale and high-frequency ocean processes on sound propagation across a shelfbreak. The unexpected magnitude of the mode coupling due to the complex environment has a number of important implications for acoustic tomography as well as target detection.

Relations to Other Programs

The results from this work have been useful in aspects of planning the recently completed ASIAEX field program in the South China Sea. Implications of this work have also been applied within the "Capturing Uncertainty within the Tactical Environment" DRI. Implications for sound propagation effects have also been applied within the “Effects of Sound in the Marine Environment” DRI relating to effects of sound on marine mammals.

References

Sperry, B., 1999; Analysis of Acoustic Propagation in the Region of the New England Continental Shelfbreak, Ph.D. Thesis, MIT/WHOI Joint Program, 179 pp.

Lynch, J., A. Newhall, B. Sperry, G. Gawarkiewicz, P. Tyack, and C.S. Chiu, 2001: Spatial and temporal variations in the acoustic propagation characteristics at the New England shelfbreak front, submitted to the *IEEE Journal of Oceanic Engineering*.

Sperry, B., J. Lynch, G. Gawarkiewicz, and C.S. Chiu, 2001: Characteristics of acoustic propagation to the eastern vertical line array receiver during the summer 1996 New England shelfbreak PRIMER experiment, submitted to the *IEEE Journal of Oceanic Engineering*.

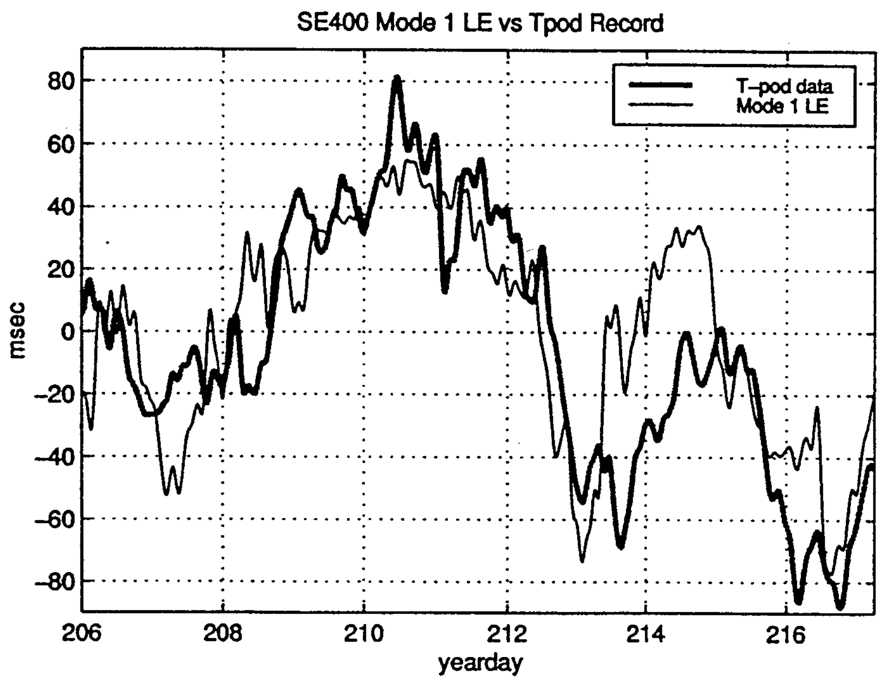

Figure 1. Leading edge arrival of mode 1 versus theoretical travel time perturbation based on data (thermistor chain). The duration of the mooring deployment was 11 days (July/August).

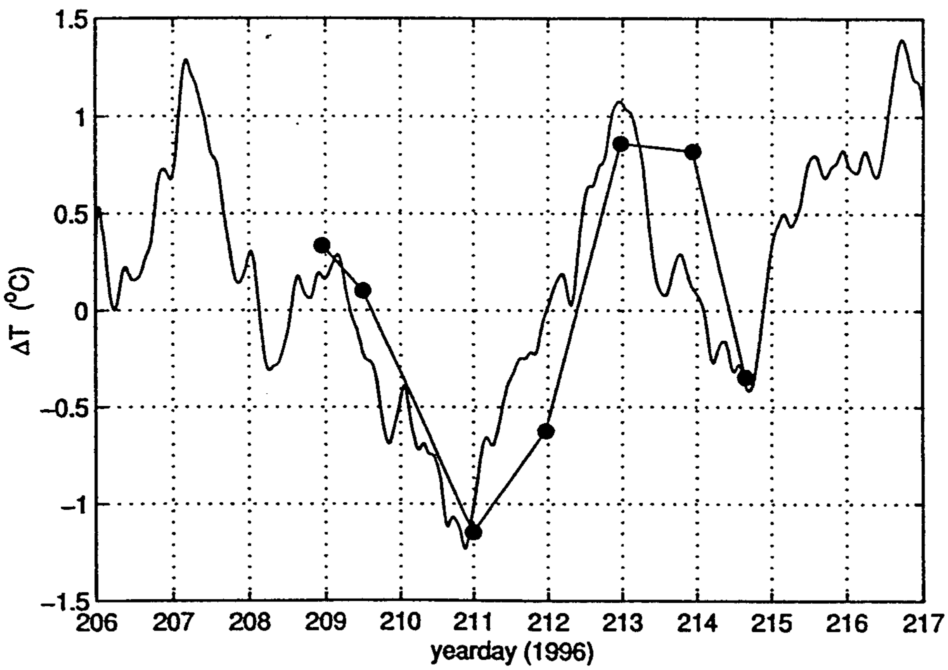

Figure 2. Time history of the depth-averaged temperature along the propagation path. The solid line is from the receiver, and the solid line and points are model results along the SeaSoar data.

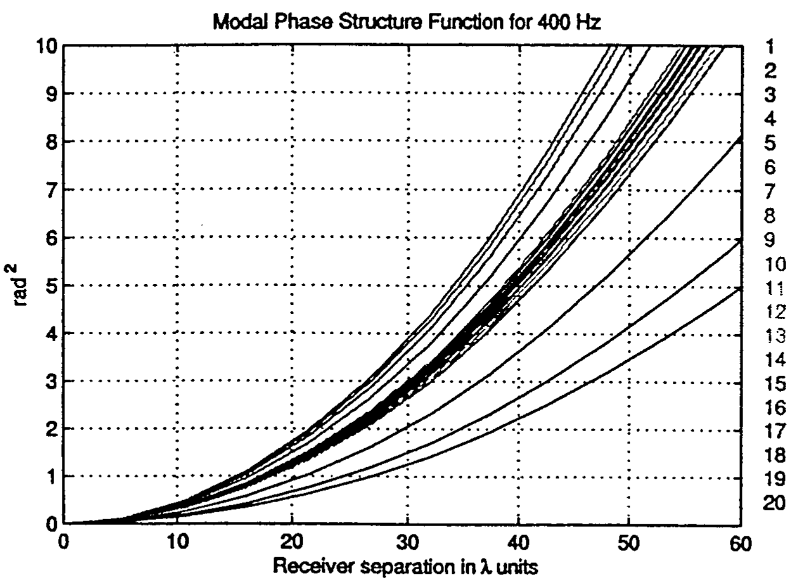

Figure 3. The phase difference function versus receiver separation distance in multiples of the wavelength. The curves are modes 1-20 with increasing difference with mode number at a given receiver separation.